

A NEW PUBLICATION METHOD

THE PCMI MICROFORM SYSTEM

pcmi
TRADE MARK

A NEW PUBLICATION METHOD

THE PCMI MICROFORM SYSTEM

A NEW PUBLICATION METHOD - THE PCMI* MICROFORM SYSTEM

A new process which makes it possible to reproduce in excess of 3200 8-1/2" x 11" pages on one small transparency has been developed by The National Cash Register Company. In addition, any desired number of dissemination copies can then be read on specially designed reader units.

NCR believes that this process, the PCMI Microform System, is an answer to the problem of storing and disseminating the enormous quantity of books, pamphlets, reports and documents being produced today.

A new type of film is used in NCR's PCMI process. It consists of a molecular dispersion of photochromic (light-sensitive) dye on a suitable substrate. Normally transparent, the molecules of photochromic dye become opaque when exposed to ultraviolet light. If an image is projected on the photochromic film, it is immediately visible, without a development process.

Unlike conventional photographic film, photochromic films are completely grain-free, and are capable of very high resolution. They will retain images with resolution greater than 1000 lines per millimeter.

At the reduction ratios achieved, the equivalent of eight average books can easily be recorded on one 105mm x 148mm piece of film. This means that a file of 1,000,000 book pages can be contained in a stack of film cards less than six inches high. A library of 60,000 volumes could be stored in one drawer of a file cabinet.

The light sensitive reaction of NCR photochromic dyes is reversible. After being changed to an opaque state by exposure with ultraviolet light, the molecules of photochromic dyes will revert to their normal transparent state upon the application of heat or visible light. Thus, if a defect occurs in forming a micro-image, the image can be erased and corrected.

* PCMI is a trademark of The National Cash Register Company.

This ability to edit the micro-images eliminates a major obstacle to the use of high reduction ratios which have been achieved before by other processes. Experience has shown that, in general, the higher the reduction ratio, the higher the error rate. Typical errors are improper focusing, film flaws and human errors. With the PCMI system, mistakes can be corrected.

Presently, microfilm is the most widely used process for reducing the bulk of printed matter. The PCMI process does not replace microfilm; rather, it offers a new dimension to the microform industry, a way of "micro-filming microfilm".

Mass Production Copies

A further program carried on by NCR was directed toward solving the problems of mass producing high quality, high reduction micro-images. Three such problems were solved by the nature of the photochromic material itself.

First, as might be expected, was the consideration of image quality. Because the materials used are molecular dispersions, photochromic reaction occurs at the molecular level and the resolution capability of these coatings is, for practical purposes, unlimited. Second, as reduction ratios go up, focus and exposure become increasingly critical. However, since the micro-images formed on the photochromic film are immediately visible upon exposure, focus and exposure may be quality inspected as the images are formed. Third, the irreversible nature of conventional photographic materials, coupled with the critical nature of a high resolution micro-image process, had largely frustrated previous attempts to create a multitude of high quality micro-images on a single substrate. But with photochromic materials, defective images may be erased and corrected whenever they occur. These, then, are fundamental advantages of the PCMI microform process. In addition, the capability of the

process to reproduce tones and thus handle photographs allows creation of micro-images from a wide range of input documents.

Figure 1 depicts the significant steps in the process of creating PCMI microforms. A two-step reduction technique is employed; it begins with the creation of high quality microfilm. At present 35mm sprocketed microfilm is used at a reduction ratio which is most compatible with the input document size, the nature of the data recorded on the document, and the physical limitations of the microfilm itself. For 8-1/2" x 11" documents which contain no printed characters smaller than 10 point size, a reduction of about 12:1 is quite satisfactory. Quality control, a critical consideration throughout the process, begins here since it is obvious that maximum detail and clarity must characterize the microfilm if the ultimate micro-image is to be acceptable. The microfilm is processed and inspected for defective images, water marks, and the like, and retakes are made as necessary. The retakes are spliced into position, replacing the original defective images, and a single input reel is created. This input reel contains the two to three thousand frames required to fill a PCMI master plate.

The second reduction step is accomplished by means of a device known as a Camera-Recorder. Within this device is a glass plate coated with photochromic material. The reel of microfilm is mounted on the Camera-Recorder and near ultraviolet light is passed through each frame. The image from each frame is further reduced either 10 or 20 times and the resulting micro-image is focused on the photochromic master plate. For each image, the Camera-Recorder also projects an appropriate row-column number to facilitate indexing. Automatic mechanisms position the photochromic coated glass plate and advance the microfilm on a step and repeat basis until the

entire micro-image matrix has been created on the plate. A binocular microscope, integrated into the Camera-Recorder, permits the operator to inspect the micro-images, either as they are being formed or after the plate has been completed. The entire Camera-Recorder operation for a 2,000-image matrix requires about two hours.

Owing to the nature of the photochromic material, the micro-images are only semi-permanent in nature. Therefore, to provide permanent master or "printing" plates, several high resolution photographic masters are contact printed from the photochromic master plate. These photographic master plates are processed and inspected. They are then utilized in automatic contact printers which produce the desired number of dissemination copies. The rolled output is processed and a protective laminate is applied. The film is cut to standard dimensions (105 x 148mm), inspected and prepared for customer shipment.

Although the primary purpose of the laminate is to protect the photographic emulsion from involuntary damage (e.g., dirt, scratches, harmful atmospheric elements, etc.), several other benefits accrue from it. The resulting transparency is quite rugged and requires no additional mounting or frame to facilitate handling or file manipulation. Further, dirt, fingerprints, and scratches on the surface of the laminate are beyond the extremely short depth of focus which characterizes high magnification systems. Such surface defects do not, therefore, adversely affect the projected micro-image to any significant degree.

Copy Protection

The dissemination copies combine the archival properties of high quality silver halide images with the physical protection of plastic laminate. Perhaps more important when considering PCMI as a publication medium, the

laminate on each dissemination copy positively precludes contact printing of any additional microform copies. Individual pages may be duplicated, one at a time, as with any other publishing medium. But to do so beyond a few pages would not be competitive with the cost of obtaining an entire transparency from the publisher. This positive control over unauthorized and illegal duplication affords ample protection to the publisher.

Results

Although resolution is by no means the sole determinant of image quality, it does provide a convenient means for objective evaluation.

For microfilm input, NCR has specified 120 lines per millimeter as minimum if high quality micro-images are to result. Owing chiefly to optical limitations within the Camera-Recorder and to two subsequent generations of contact printing, dissemination copies typically afford resolution of 650 to 750 lines per millimeter. Using these figures, a PCMI microform at 150x reduction provides image quality comparable to high quality microfilm at 30:1.

Cost

Of the many attributes which make the PCMI system an attractive micro publishing media, perhaps the most relevant and certainly the most practical is cost. As might be assumed for the detailed and highly critical nature of the process involved, the cost of creating the photographic master printing plate is appreciable. The exact price depends upon the number of master plates required and upon the number of images per master plate. The price of each dissemination copy is constant regardless of the number of images thereon.

The economic advantage of the PCMI system exists where there is a requirement for a large number of copies. The cost of preparing the master plate may then be prorated over the number of copies and the per copy cost approaches one dollar as a lower limit. Figured on a cost per image basis, the cost is usually 1/20th of a cent or less per page.

Reading Equipment

Reductions well beyond 250:1 (62,500 times area reduction) are practical to attain with PCMI. However, information on microfilm has little practical value if suitable reader equipment is not available. Some of the factors considered when designing PCMI reader equipment were:

1. Optical magnification desired
2. Screen brightness
3. Screen size
4. Image quality
5. Lamp life
6. Reader unit cost

The combination of these parameters which NCR feels will fulfill the requirements common to most users were built into low-cost readers. One of these has a fixed magnification of 115 times. This allows storage of over 2,000 micro-images on a single transparency (assuming documents which are 8-1/2" x 11" and a full-size image of the original on the screen). The open aperture screen brightness on this model is in excess of 60 foot-lamberts when measured axially at a distance of 15 inches from the screen. The screen size is 11" square to accommodate an 8-1/2" x 11" image oriented either vertically or horizontally. A low monthly rental cost of the 115x has been established, depending upon the rental period and upon whether or not full service coverage is included. NCR feels that this combination of performance versus price will find broad acceptance in application areas where wide dissemination of volume data is required.

Another reader features 150x magnification which allows more than 3200 images per transparency.

We are aggressively continuing our research efforts to enable us to find a satisfactory combination of such factors as screen brightness, lamp life and image quality to enable us to provide readers with magnifications well beyond our current capabilities.

As A Publishing Media

What are the principal implications of the PCMI Microform System as a publishing media? They fall into two general classes of publishing, in-house and commercial.

By in-house is meant the publication of material for internal use by any large organization which does business on a widely decentralized basis. In addition to utilizing the PCMI system as previously described, i.e., hard copy to microfilm to PCMI, recent developments in computer technology give rise to some fascinating new systems possibilities.

Consider the information handling pattern which came about during the early years of electronic data processing. Information from field business locations was delivered to a centralized EDP installation where it was sorted, manipulated and combined to produce important new reports. Suddenly there was more information in a more useful form than had ever been available prior to EDP. These reports were produced and disseminated, but only on a limited basis, due to the time and cost of producing multiple copies. Indeed the output of this information by means of high speed line printers sometimes took longer than did its creation. Even the best line printer currently available is limited to under 10 legible copies produced

from a single printing operation. Dissemination copies produced in this fashion must be decollated and possibly bursted and bound.

It has become evident to business management that although there is more information available within their EDP installations, the maximum benefit can be derived only when this information is made available to the field locations where it can be acted upon. EDP equipment manufacturers responded to this need with a dazzling array of data communication networks, on-line systems, and the like. But the cost to disseminate vast quantities of information to a large number of field locations by such a system is often staggering. Besides, the speed afforded by these systems is not always required.

Several years ago, a significant development occurred in the area of computer output. Devices became available which could, at the rate of thousands of characters per second, accept information from either a computer or from magnetic tape, display this data on a cathode ray tube, and trigger a microfilm camera to record the CRT display. The microfilm could then be used as 1) the dissemination copy itself, 2) a master copy from which dissemination microfilm copies could be contact printed, or 3) input to a device which would produce the required hard copy for distributional purposes.

The PCMI system adds an important alternative in this connection. Computer-generated microfilm can be produced which is suitable for input to the PCMI process. PCMI microforms thus provide a most economical vehicle for transmitting this information to decentralized locations.

User Acceptance

With regard to commercial publishing, some significant points relative to economic feasibility, protection against unauthorized duplication,

etc., have been previously discussed. What about user acceptance? Here the question is not whether the user will accept microforms as readily as books, but, rather whether the user will resist this change to the extent of making its implementation impossible.

Certainly a great missionary effort is involved in attempting to bring about so dramatic a change in form as from books to PCMI microform. But there is ample reason and cause to attempt it. The so called "information explosion" is much publicized and widely lamented by frustrated researchers, managers, educators, librarians, and other professional people. The situation is compounded by a second "explosion" represented by our burgeoning population. Volumes of statistics have been cited which indicate that these problems are critical today and are certain to get progressively worse. Recently enacted federal legislation recognizes the problem as both national and international in scope. Microphotographic storage such as the PCMI system has the following strong economic and logical reasons for its inclusion in any proposed solution:

1. Conversion of existing literature would be simplest and most economical.
2. Information stored in this form could be indexed with equal facility by nearly all present indexing systems.
3. Maximum storage density is achieved.
4. Graphic, photographic, and alphanumeric information may be stored with equal ease.
5. The mechanics of retrieval are greatly simplified by having data in such compact form.

Additionally, the PCMI Microform System alone offers the following unique combination of capabilities:

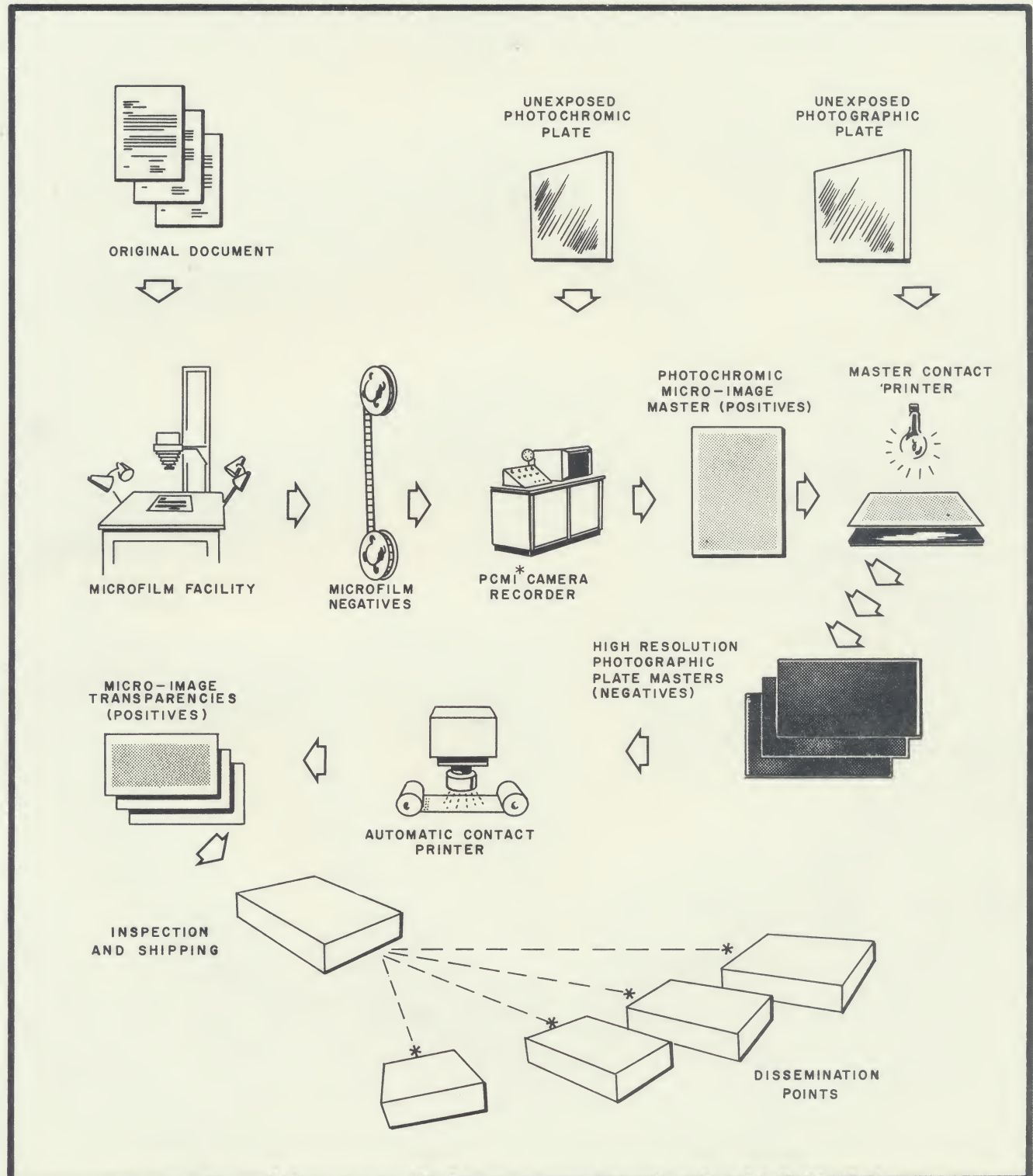
1. NCR photochromic films provide very high resolution capability.
2. Images created using photochromic film are immediately visible upon exposure.

3. Images created using photochromic materials may be erased and rewritten, thus providing a facility for updating, editing, and error correction.
4. A wide range of alphanumeric, graphic, and photographic documents can be effectively stored.
5. The PCMI process provides permanent silver halide dissemination copies on an economical mass production basis.
6. The very high storage density intrinsically reduces the problems of data access and manipulation.

The PCMI Microform System will make a significant contribution to the task of making more information more readily available to more people. This, after all, is the basic function of publishing.

FIGURE 1

NCR MICROFORM PROCESSING CENTER



* PCMI is a Trademark of The National Cash Register Company

THE NCR CLASS 455 PCMI[®] TRANSPARENCY READER UNIT



The new NCR Class 455 Reader has been developed to provide a low cost, high quality device for viewing information in micro image form. Full attention has been given to every detail of design and human engineering. The result is an outstanding product which is efficient in use and virtually maintenance free.

It may be operated by nearly anyone after a brief introduction to its simple access mechanism. A PCMI transparency containing up to 3200 images is inserted between a hinged pair of glass plates. The glass plates perform the dual function of 1) holding the transparency in a plane, and 2) acting as a heat sink to afford an extra measure of protection against heat damage. An almost effortless operator movement will allow the entire cover glass assembly to be moved in the x or y direction, singly or in combination, until the desired image has been positioned for viewing. Throughout this movement, the optical system has mechanically "tracked"

the image plane so that only a touch of the fine adjustment ring may be required to bring the entire image into sharpest focus.

The illuminating source is an advanced design quartz-iodine cycle incandescent lamp. The life of this lamp contrasts favorably with conventional light sources and, because it is not subject to the usual internal blackening, its brightness is constant throughout.

The 11" by 11" coated screen is designed to assure image detail clarity and uniform brilliance. As an option, an adjustable cover assembly can be provided to shield the screen from ambient glare sources.

In consideration of the unique requirements for magnifying and projecting images above 100 power, a special lens system was designed exclusively for use in the Class 455. The design and construction specifications for the fine optical system are representative of the overall quality and precision inherent in this unit.



INDUSTRIAL PRODUCTS DIVISION

DAYTON • NEW YORK • WASHINGTON • LOS ANGELES • TOKYO
AMSTERDAM • FRANKFORT • LONDON • MILAN • STOCKHOLM • PARIS

SPECIFICATIONS:

Construction:

A quality optical mechanism integrated into a durable frame.

Size and Weight:

26" high, 16" wide, and 24" deep;
Shipping weight-48 pounds (approx.)
Net Weight-40 pounds

Viewing Screen: Size:

11" x 11" with 1-1/4" radiused corners with added visual facility for row/column indication.

Type:

Rear projection, translucent, diffused surface type for sharp high contrast, brilliant and clearly illuminated images.

Color:

White

Illumination Source:

150-watt, 21-volt long-life quartz-iodine cycle incandescent source. Gives high intensity, even illumination. A quiet and efficient cooling fan is in operation whenever light source is operating.

Focus Control:

Lens system "tracks" the image plane so that gross focus is always maintained. Fingertip controlled fine focus accomplished with conveniently placed knurled ring.

Optical System:

Choice of precision microscope type 115X or 150X specially designed, plano-optical system. Heat absorption glass protects film against heat damage.

PCMI Transparency Input:

Positive images for maximum clarity. Plastic laminated transparencies 105 mm. x 148.75 mm.

Access Mechanism:

Manually operated, inverted T arrangement allows transparency holder to glide smoothly on Teflon-coated bearings to any desired X-Y position. Simple, efficient and trouble-free direct access.

Electrical:

Single phase power source
47 to 63 cps at 90 to 127 volts
47 to 63 cps at 200 to 260 volts

Environment: Operating:

Between 32°F. and 115°F.
Between 5% and 98% relative humidity
Between -40°F. and 180°F.

Non-Operating:

*PCMI is a trademark of The National Cash Register Company.